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AUTHORS: (8) Podstrigach, Ya. S., Kruchkevich, V. Yu.

TITLE: (6) Forced thermo-elastic oscillations in cylindrical and spherical bodies

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TEXT: The purpose of this study was the determination of non-stationary temperature fields in hollow cylinders and spheres and the calculation of resulting stresses. The authors determine the temperature field in a hollow body (infinite cylinder, sphere) whose surfaces exchange heat with a surrounding medium of constant temperature in accordance with Newton's law. The temperature of a medium filling up the body varies by a periodic law. Using the equation of heat conductivity and corresponding boundary and initial conditions the general solution of this equation is sought for in the following form:

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$$t_\nu(\rho,\tau) = t_{\nu 0}(\rho) + t_{\nu 1}(\rho) \cos \omega^* \rho + t_{\nu 2}(\rho) \sin \omega^* \tau + t_\nu^*(\rho,\tau) \qquad (5)$$

where ρ is dimensionless radial coordinate r/R_2 (R_2 is external diameter of the body); $\nu = 1$ pertains to cylinder, $\nu = 2$ pertains to sphere. After a certain time interval, asymptotic thermal conditions set in and the temperature at any point oscillates with the same period as that of the inner medium, but with a different amplitude and phase shift. Rigorous solutions are found for the case of a hollow cylinder in terms of Tompson functions, and for the case of a hollow sphere in terms of hyperbolic functions. As an example, a practically important case of pipelines in thermal electric power stations is considered, when the outer surface of the cylinder (pipeline) is thermally insulated. The second problem dealt with is the determination of the stressed-strained state of the bodies subjected to forced thermo-elastic oscillations caused by periodic changes of temperature according to the same law (5). To calculate stresses, formulae derived by L. I. Lur'ye ("Prostranstvennyye zadachi teorii uprugosti", Spatial problems of the theory of elasticity, GITTL, 1955) are used. The expressions for radial and tangential stresses are inserted into the equation of equilibrium, and the differential equation obtained for displacements $U_\nu(\rho,\tau)$ is solved.

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Then, using this solution and expressions for stresses given by Lur'ye, the authors derive formulae for radial $\sigma_\rho^{(\nu)}$ and axial σ_z^{ω} stresses. For the latter case, conditions of axial strain are of importance. Two cases, when the cylinder ends are fixed and free, are considered and corresponding formulae for axial stresses are presented. The formulae are considerably simplified when inertia forces can be neglected. Comparing the results with the known Timoshenko's formulae for a quasi-stationary problem, the authors conclude that the formulae derived in the present article represent a generalization of Timoshenko's formulae extended to the case of steady-state conditions of forced oscillations.

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